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Searching for a multifractal signature of the lake algal proliferation, a multifractal correlation

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Green algae proliferations affect water bodies such as the Lake Bourget (France). They are an environmental issue as well as a mater of public health. In the framework of the PROLIPHYC project a system based on temperature and chlorophyll measurements coupled to a lake model was implemented to predict sudden algal blooms.

This classical approach relies on the analysis of large scale trends of the measured fields and does not take into account small scale fluctuations. A more innovative approach has been developed by the R2DS PLUMMME project to investigate the correlation between environmental fields across the full range of space-time scales, down to the smallest scale of observations.
The first results of the project demonstrate that multi-scaling behaviour of environmental fields, such as temperature and chlorophyll, becomes evident only after the removal of the large-scale data trends that otherwise induce biases to the multifractal parameter estimates.

First, a spectral analysis of temperature and chlorophyll data is performed on sub-samples of the time series to investigate the scaling behaviour. The multifractal analysis (Trace Moment, Double Trace Moment) directly applied on each sub-sample shows unsatisfying results on some sub-samples, in particular on those having a strong gradient compared with the amplitude of the fluctuations. Hence, non-stationary and seasonal effects should be first removed from the time series. To put on evidence a good scaling of the analysed data, we choose the Hilbert-Huang transform to de-trend the data. This method has been widely used for different fields (see F.G.Schmitt et al, 2009 for review). After having applied this method, the K(q) function shows that the investigated fields are indeed multifractal and the determination of their multifractal parameters becomes robust. Then, we proceed to a multifractal correlation analysis between the fields.

In conclusion, we discuss the prediction of algal blooms based on multifractal cross-correlations with temperature across scales.